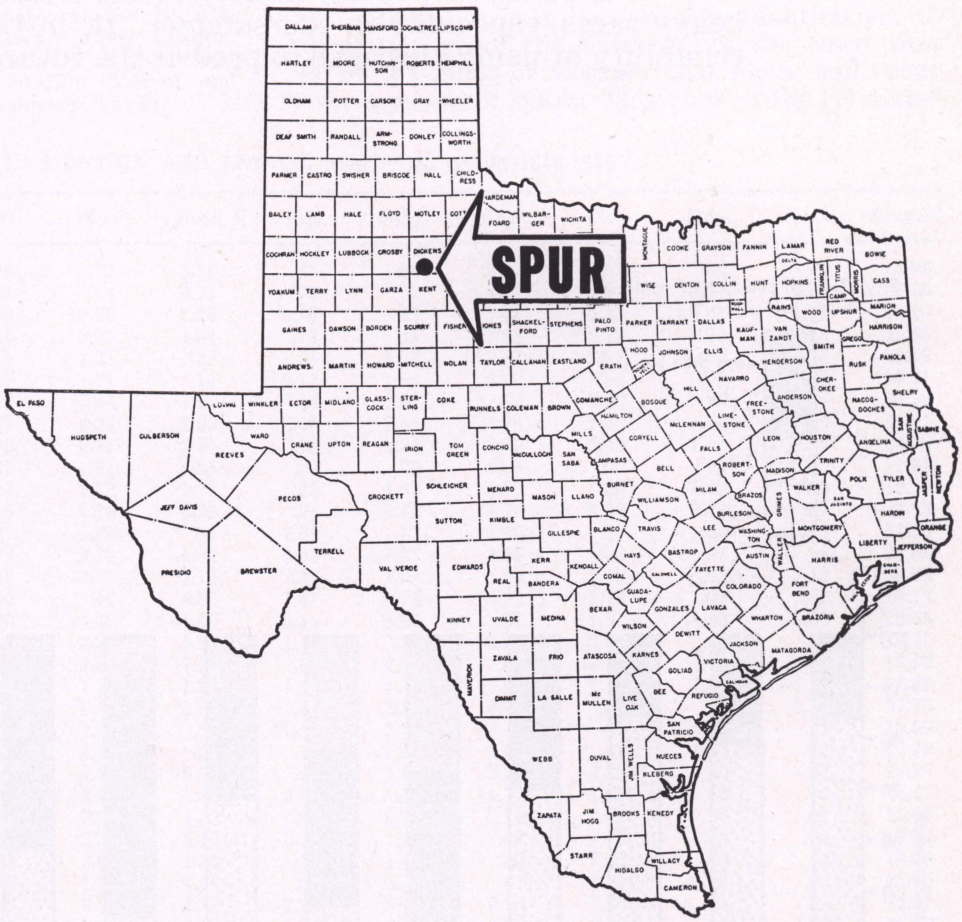
MP-262

• RAINFALL

• at

• Spur, Texas



February 1958

TEXAS AGRICULTURAL EXPERIMENT STATION

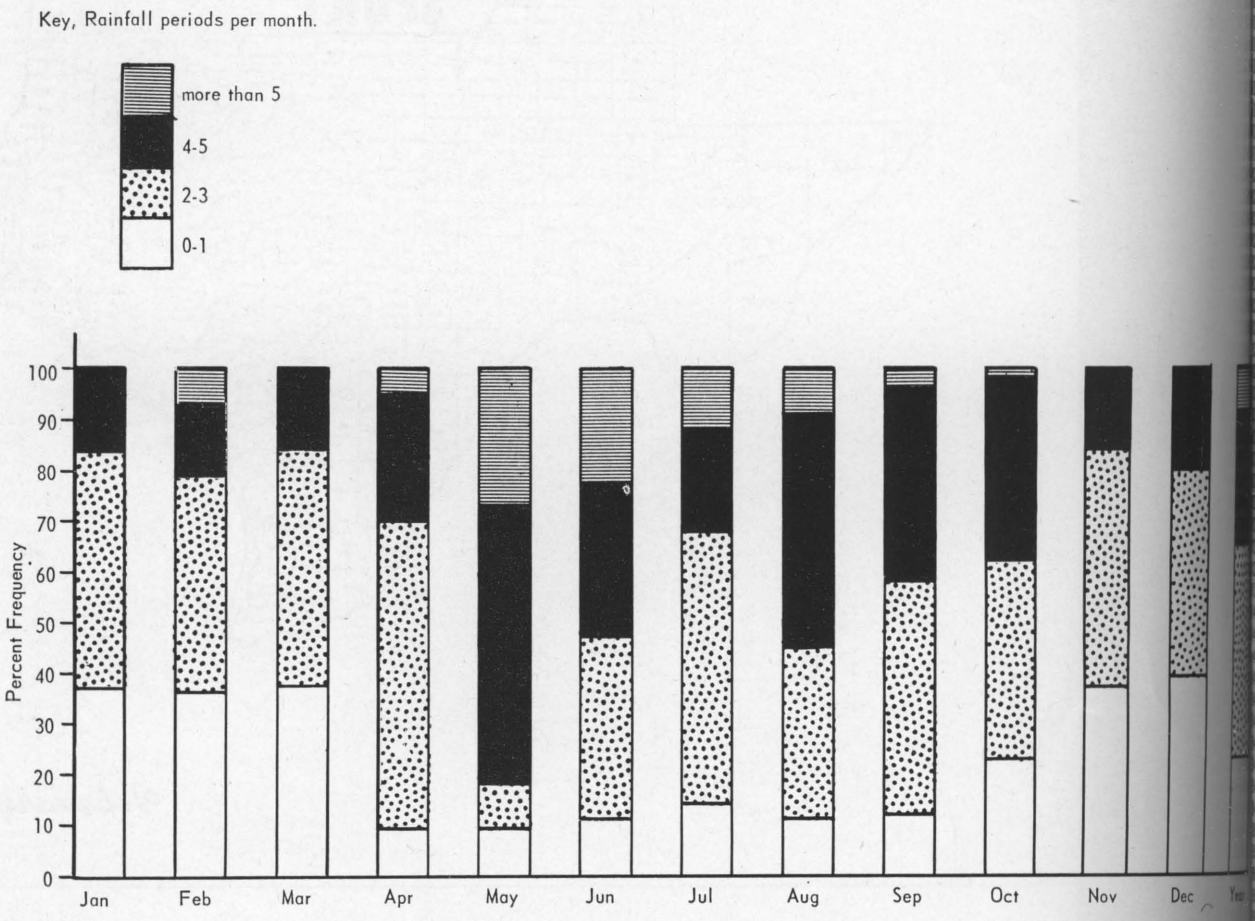
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

SUMMARY

Great variability exists in the rainfall at Spur over 44 years of record.

The rainfall data were analyzed by rainfall periods, months and years. Annual rainfall varied from 11.09 inches in 1924 to 42.87 inches in 1941. The variability of monthly rainfall is illustrated by the records for May, where 0.08 inch occurred in 1945 and 10.58 inches occurred in 1914. More than half of the rainfall periods which occurred during the 44 years brought less than one-half inch of rain, while more than 5 inches of rain occurred in 5 of the 1,527 rainfall periods.

This variability is due largely to the effect of infrequent heavy rains, especially in the summer. It, in turn, limits the reliability of using averages to predict the future.



Percent frequency of rainfall periods by months and annually.

Rainfall at Spur, Texas

W. G. Covey, R. J. Hildreth and C. E. Fisher*

WEATHER OBSERVATIONS AT SPUR have been taken since April 16, 1911 by Substation No. 7, Texas Agricultural Experiment Station. These include daily observations of rainfall, temperature, evaporation, relative humidity of the air, wind movement and direction and certain other related weather phenomena. Since crop production on the Rolling Plains is governed largely by the amount of water available for plant growth, analysis of rainfall has been made in relation to the conservation and utilization of rainfall in previous reports.[1 2 3]

This study describes certain features of the rainfall at Spur during 1912-55. For the most part, only the daily readings from a standard rain gage are used; however, the data on the intensity of rainfall previously reported by Fisher and Burnett[3] and others were obtained by a recording rain gage. One value of studying past weather data is to provide a guide for the future. These studies do not make possible weather forecasts far into the future, but provide quantitative information about the "climate" of the place, that is, of the kinds of weather that likely will occur over a period of years. This view of the "climate"

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TABLE 1. MONTHLY AND ANNUAL RAINFALL, SPUR, 1912-1955

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
12	.00	1.15	1.02	1.99	.53	3.14	.53	1.66	2.04	1.87	.00	.60	15.05
13	.04	.41	1.23	.77	.44	4.35	.70	.07	5.72	2.94	3.64	1.89	22.20
14	.09	.19	.33	1.99	10.58	1.28	4.70	5.89	1.41	5.23	.87	1.57	34.13
15	.40	2.10	3.20	7.64	2.31	4.08	.78	1.48	7.65	5.17	.00	1.05	35.86
16	.00	.00	.43	2.35	1.31	2.36	.56	4.01	1.12	2.63	.82	.00	15.59
17	.22	.51	.00	1.27	1.71	.14	2.17	1.58	4.12	.12	.07	.00	11.91
18	.00	.64	.30	.62	2.44	1.97	.44	1.42	.92	2.60	.20	1.37	12.92
19	.28	.21	3.56	3.78	4.37	2.03	2.60	2.44	4.26	7.48	.80	.00	31.81
20	1.31	.00	.16	.99	6.91	3.36	.75	8.34	2.20	2.49	1.11	.38	28.00
21	.30	1.08	.66	.00	.91	4.45	.00	.09	4.08	.00	.00	.05	11.62
22	.31	.00	.76	5.57	5.18	1.77	.25	1.60	1.00	1.06	1.80	.03	19.33
23	.05	.85	1.01	3.89	1.14	4.95	.26	1.40	1.57	6.58	2.36	.87	24.93
24	.00	.09	1.88	.81	1.98	.65	2.01	.87	2.00	.80	.00	.00	11.09
25	.34	.16	.19	4.77	2.75	1.74	3.43	7.37	3.66	.73	.22	.24	25.60
26	.67	.04	1.62	4.18	3.17	2.14	7.37	7.04	3.50	5.13	.52	2.70	38.08
27	1.10	.26	1.06	.40	.66	4.56	1.47	.78	4.22	1.19	.00	.42	16.12
28	.24	.96	.36	.20	4.33	1.60	5.15	3.97	.05	1.37	1.43	.33	19.99
29	.27	.21	1.49	.02	2.80	1.23	1.17	.33	3.74	3.07	.40	.03	14.76
30	.86	T	.43	1.66	1.54	1.28	.05	2.05	.89	6.53	.75	2.56	18.60
31	.79	1.62	.33	2.18	1.22	1.29	1.80	1.14	.00	2.53	2.42	1.14	16.46
32	1.71	2.39	T	1.91	1.43	3.38	2.67	5.55	4.24	.58	.09	3.75	27.70
33	.19	1.47	.00	.15	2.86	.00	2.51	3.32	3.17	.35	1.12	.45	15.59
34	.12	.21	2.20	1.16	2.50	.07	.11	1.18	2.52	.87	1.93	.01	12.88
35	.01	.61	.98	.71	4.54	6.93	.99	1.05	3.62	2.22	1.50	.62	23.78
36	1.11	T	.22	2.49	2.79	1.43	2.85	.11	11.13	1.41	.48	.45	24.47
37	.38	T	2.05	.86	2.92	1.31	.68	6.93	2.18	2.47	.09	.41	20.28
38	1.14	3.31	.82	.89	2.89	5.16	3.30	.21	.09	1.33	.78	.04	19.96
39	1.98	.25	.52	.29	2.07	1.80	.44	1.85	.00	2.62	.60	.64	13.06
40	.16	1.14	.00	1.79	1.17	1.06	.07	3.24	.41	1.34	3.16	.04	13.58
41	.88	1.64	2.04	4.17	6.94	4.12	2.94	1.46	9.90	7.90	.21	.67	42.87
42	.06	.33	.31	3.67	1.63	3.44	1.60	3.40	3.88	2.82	.17	1.79	23.10
43	.10	.00	.32	1.14	2.81	2.95	5.36	.00	2.37	.31	.80	1.64	17.80
44	1.77	1.78	.12	.89	2.49	2.50	2.51	2.34	1.18	1.07	1.95	2.72	21.32
45	.89	1.04	.34	.58	.08	3.30	4.29	1.78	4.27	2.12	.69	.21	19.59
46	1.05	.19	.36	1.40	1.57	3.33	.05	3.71	2.48	2.78	.32	1.68	18.92
47	.60	.00	1.51	1.27	6.43	2.01	.00	.28	.15	.65	2.14	2.03	17.07
48	.18	2.28	.15	.57	2.00	4.78	1.30	.89	.07	1.58	.45	.08	14.33
49	2.50	.43	1.78	1.62	5.28	4.63	2.45	4.06	2.71	2.64	.00	1.08	29.18
50	.35	.38	.01	1.94	4.92	3.16	3.91	.90	6.23	.00	.04	.02	21.86
51	.27	.35	2.19	.81	3.01	2.88	2.30	5.82	1.29	2.29	.03	.00	21.24
52	.70	.21	.23	3.33	1.36	.06	2.81	.46	1.22	.00	1.25	.86	12.49
53	.55	.79	.86	1.82	2.81	2.55	2.03	2.50	2.77	2.39	.83	.87	15.48
54	T	T	.14	2.51	5.90	.23	.07	1.39	.10	1.56	1.07	1.11	14.08
55	1.02	.51	1.08	.36	6.60	3.99	2.63	1.14	3.23	3.97	.02	.00	24.55

TABLE 2. AVERAGE RAINFALL BY 10-DAY PERIODS, SPUR

Month	Third	Number of days	Average rainfall, inches	Standard deviation, inches	Adjusted and smoothed mean, inches
January	1	10	.276	.39	.21
	2	10	.130	.18	.18
	3	11	.150	.30	.14
February	1	10	.146	.26	.17
	2	10	.240	.46	.25
	3	8¼	.291	.45	.28
March	1	10	.261	.51	.27
	2	10	.208	.35	.28
	3	11	.396	.64	.32
April	1	10	.387	.69	.43
	2	10	.536	.66	.60
	3	10	.885	1.07	.81
May	1	10	1.005	1.07	.97
	2	10	1.014	1.06	.97
	3	11	.988	1.29	1.01
June	1	10	1.120	1.11	.92
	2	10	.749	.89	.84
	3	10	.658	.97	.71
July	1	10	.720	1.10	.62
	2	10	.484	.64	.62
	3	11	.728	1.09	.59
August	1	10	.637	.91	.67
	2	10	.709	1.05	.79
	3	11	1.118	1.42	.88
September	1	10	.907	1.07	.96
	2	10	.960	1.26	.92
	3	10	.885	1.45	.94
October	1	10	.979	1.20	.88
	2	10	.769	1.20	.82
	3	11	.797	1.17	.58
November	1	10	.237	.37	.42
	2	10	.281	.50	.28
	3	10	.308	.52	.32
December	1	10	.380	.62	.29
	2	10	.189	.30	.26
	3	11	.241	.51	.23

as something that prevails and is revealed by daily observations of changing weather from year to year has proved useful. The lay of the land, distances to mountains and oceans, rotation of the earth, heat output of the sun and other such general features do not change noticeably over several generations.

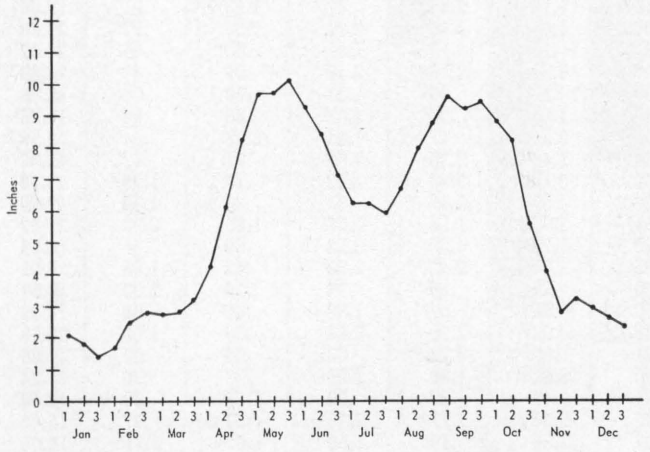

Figure 1. Weighted average of rainfall by 10-day periods, Spur.

TABLE 3. PROBABILITIES OF ANNUAL RAINFALL MORE THAN AND LESS THAN VARIOUS AMOUNTS, BASED ON 44 YEARS OF RECORD (1912-55), SPUR

Inches of rain	Probability for more, percent	Probability for less, percent
0	100.0	0.0
2	100.0	0.0
4	100.0	0.0
6	99.9	0.1
8	99.2	0.8
10	96.6	3.4
12	90.9	9.1
14	82.0	18.0
16	70.4	29.6
18	58.4	41.6
19.41	50.0	50.0
20	46.6	53.4
22	36.2	63.8
24	27.4	72.6
26	20.3	79.7
28	14.9	85.1
30	10.8	89.2
32	7.7	92.3
34	5.5	94.5
36	3.9	96.1
38	2.7	97.3
40	1.9	98.1
42	1.4	98.6
44	0.9	99.1
46	0.7	99.3

MONTHLY AND ANNUAL RAINFALL TOTALS

In the 44-year period from 1912 through 1955, a total of 936.82 inches of rain fell at Spur, an average of 20.37 inches annually, as determined by totaling the amounts of rain measured on 16,801 daily observations. The great variation in rainfall by months and by years is shown in Table 1. The rainfall varied from no inches for some months to a maximum of more than 10 inches. The average monthly rainfall shows that there is considerably more precipitation in the summer than in the winter, with approximately 84 percent of the annual rainfall occurring during the summer months, April to October. The average rainfall is not uniformly high or well distributed during the summer. The rainfall in July is distinctly lower than in the months preceding and following.

ANNUAL RAINFALL COURSE

The annual cycle of rainfall was examined by dividing the year into 10-day periods, with the average rainfall for the first and second 10-day period of each month and the remaining days adjusted to 10-day periods of the month as shown in Table 2. This table also shows a measure of variability, the standard deviations of the rainfall amounts. Approximately two-thirds of the observations can be expected to fall between the average and plus and minus the standard deviation. The relatively high values of these standard deviations indicate that the average values of 10-day rainfalls are of little use in predicting the future. This can be seen also in the ups and downs of the average rainfall by periods. To show

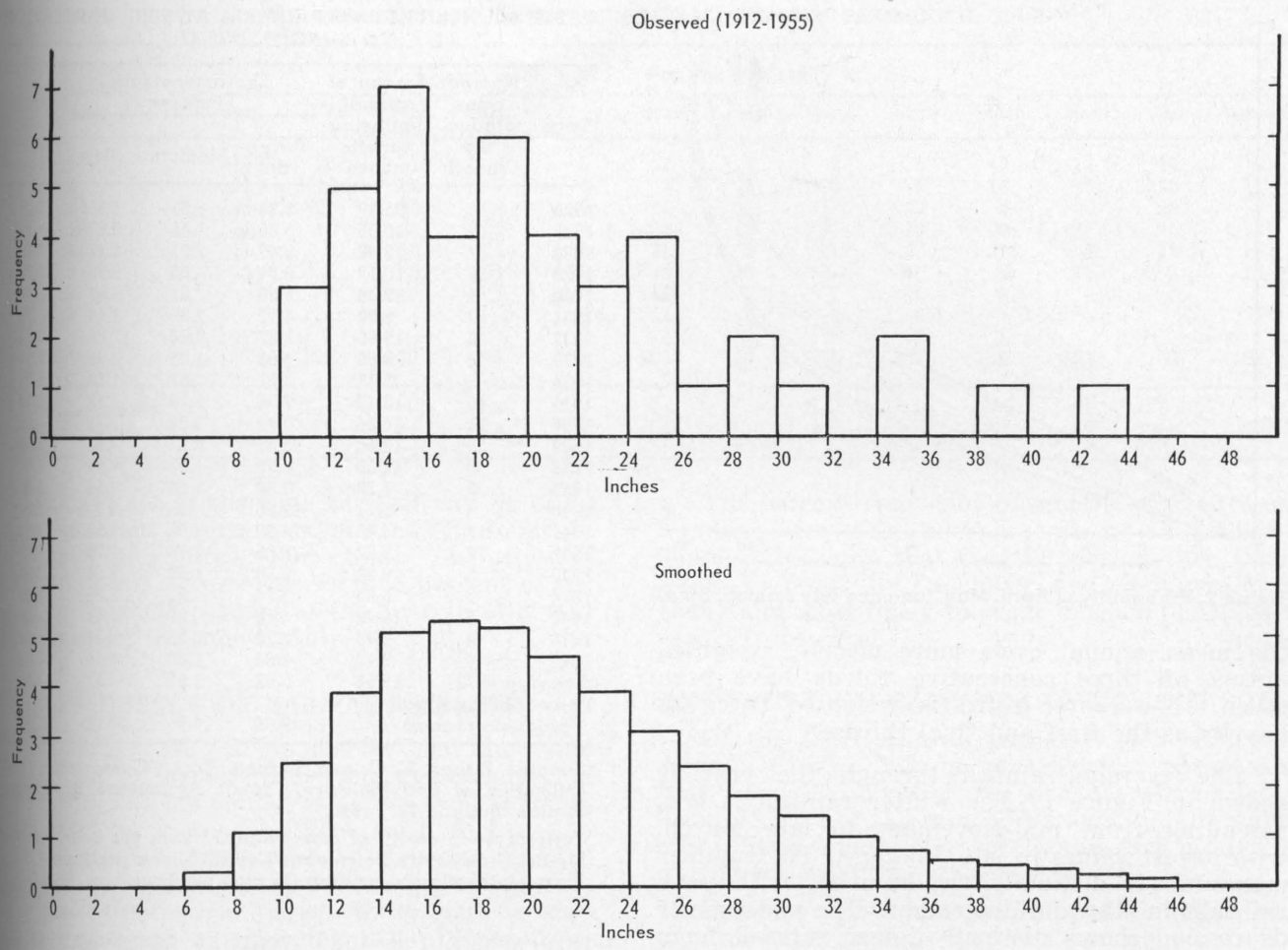

Figure 2. Top: observed frequency of annual rainfall, Spur; Bottom: smoothed frequency of annual rainfall.

TABLE 4. PERCENT PROBABILITY OF MONTHLY RAINFALL LESS THAN OR EQUAL TO VARIOUS AMOUNTS, SPUR

Inches of rain	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.00	12.7	15.4	12.4	8.5	2.2	4.6	8.9	10.3	7.0	7.0	12.9	14.9
.25	31.5	31.4	23.7	14.6	4.3	6.6	13.3	14.0	10.8	10.7	26.4	26.9
.50	51.1	47.7	36.7	21.8	7.4	9.3	18.5	18.2	15.1	15.0	41.2	40.1
.75	67.5	57.5	49.6	29.6	11.2	12.7	24.4	23.0	19.9	20.0	54.9	52.7
1.00	79.0	72.5	61.2	37.2	15.9	16.7	30.8	27.9	25.0	25.2	66.3	63.6
1.25	86.9	80.5	70.7	44.8	21.1	21.3	37.4	33.1	30.1	30.9	75.4	72.7
1.50	91.8	86.3	78.5	51.7	26.7	26.6	44.0	38.3	35.3	36.6	82.2	79.9
1.75	95.0	90.3	84.4	58.1	32.3	32.4	50.5	43.5	40.4	42.3	87.2	85.3
2.00	96.9	93.2	88.7	63.8	38.2	38.5	56.7	48.6	45.3	47.7	90.8	89.3
2.25	98.1	95.2	92.0	68.8	44.0	44.9	62.4	53.5	49.9	52.8	93.4	92.3
2.50	98.8	96.6	94.3	73.2	49.5	51.3	67.7	58.1	54.4	57.7	95.3	94.5
2.75	99.2	97.6	96.0	77.1	54.7	57.6	72.4	62.6	58.5	62.4	96.6	96.0
3.00	99.5	98.3	97.1	80.4	59.5	63.6	76.5	66.5	62.3	66.6	97.6	97.2
3.50	99.8	99.1	98.6	85.6	68.1	74.3	83.4	73.7	69.0	73.7	98.7	98.6
4.00		99.5	99.3	89.5	75.2	82.9	88.5	79.5	74.6	79.7	99.3	99.2
4.50			99.6	92.3	80.8	89.3	92.1	84.3	79.3	84.4		
5.00				94.3	85.3	93.6	94.7	88.0	83.1	88.0		
5.50				95.8	88.8	96.4	96.5	90.9	86.2	90.8		
6.00				96.9	91.5	98.1	97.7	93.1	88.8	93.0		
6.50				97.7	93.5	99.0	98.5	94.9	90.8	94.7		
7.00				98.3	95.1	99.5	99.0	96.1	92.4	96.0		
7.50				98.7	96.2		99.3	97.1	93.8	96.9		
8.00				99.0	97.2			97.8	94.9	97.7		
8.50				99.3	97.8			98.4	95.8	98.2		
9.00					98.4			98.8	96.6	98.6		
9.50					98.7			99.1	97.2	99.0		
10.00					99.0			99.3	97.7	99.2		

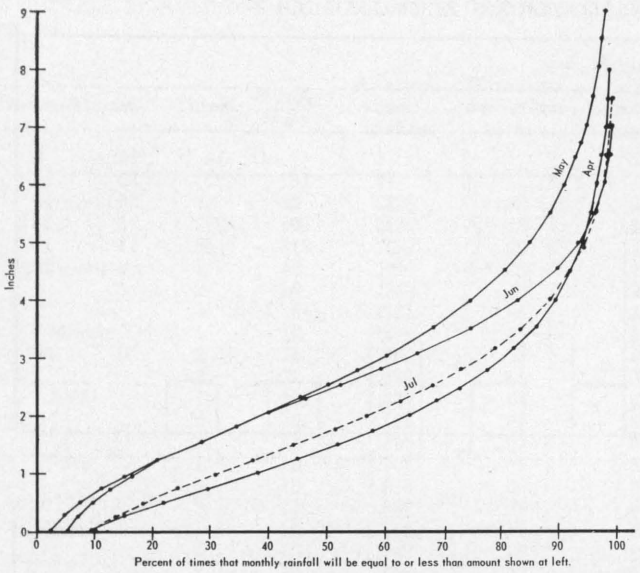

Figure 3. Probability of April, May, June and July rainfall, Spur.

the mean annual cycle more clearly, weighted means of three consecutive thirds have been taken. The center third is weighted twice as heavily as the first and final thirds.

The average rainfall through the year is shown in Figure 1. The winter rainfall is low, extending from mid-November to late March, with lowest values in late January. The summer maximum is distinctly two-humped, with peak rainfalls in May and September. The midsummer depression shows distinctly lower rainfall from mid-June through mid-August.

ANNUAL RAINFALL DISTRIBUTION

The amounts of rain which fall in various years are another main feature of the climate. Between 1912 and 1955, the greatest amount of rain which fell in 1 year at Spur was 42.87 inches in 1941, and the least amount was 11.09 inches in 1924. However, the rainfall in 1956, which was not included in the analysis, was the lowest on record, 6.87 inches. Average annual rainfall was 20.36 inches. A more complete picture may be seen in the frequency distribution of annual rainfall, Figure 2 (top). The frequency distribution of annual rainfall obtained is highly irregular, but approximates a smooth distribution which increases to a maximum value and trails off gradually to zero at high amounts of rainfall (to the right, in the graph). A smooth frequency distribution has been computed to give smoothed values of probabilities of annual rainfall of various amounts at Spur, Figure 2 (bottom). The convenience of these smoothed values should not obscure the fact that 44 years of record of a highly variable rainfall are insufficient for precise computation of means, variations and probabilities.

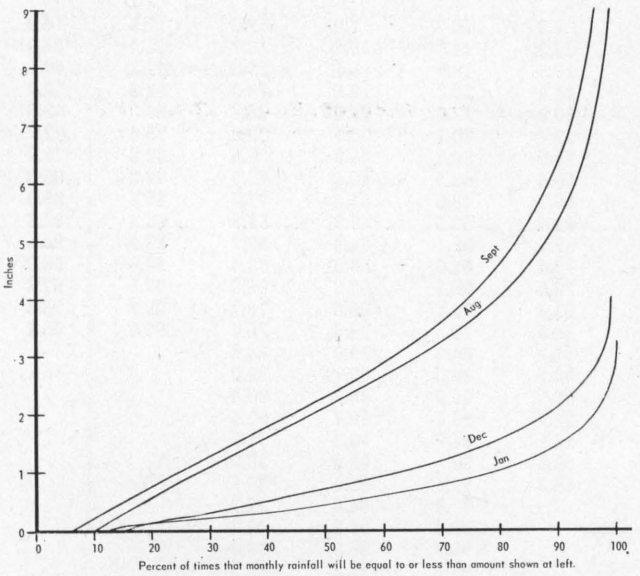

Figure 4. Probability of September, August, December and January rainfall, Spur.

TABLE 5. INTENSITY OF RAINFALL AT SPUR IN RELATION TO RUNOFF, 1926-47[1]

Year	Number rains producing runoff	Amount of rainfall producing runoff, inches	Character of rain, inches[2]			Average runoff, inches
			Torrential	Medium	Slow	
1926	14	25.30	8.78	6.97	9.55	7.03
1927	10	10.92	5.80	1.45	3.67	.91
1928	17	12.60	8.47	2.71	1.42	2.59
1929	10	10.17	6.01	.90	3.26	3.20
1930	9	12.46	5.58	.21	6.67	2.80
1931	10	8.00	4.17	2.39	1.44	.78
1932	12	19.65	5.27	2.29	12.09	2.74
1933	9	9.65	4.65	1.05	3.95	2.11
1934	5	5.35	3.21	.82	1.32	1.78
1935	10	13.42	7.06	2.18	4.18	4.77
1936	11	14.34	7.82	1.34	5.18	4.06
1937	6	12.63	5.41	2.23	4.99	3.35
1938	9	12.59	6.78	1.57	4.24	3.25
1939	6	7.20	3.30	1.38	2.52	1.20
1940	5	5.71	2.66	.28	2.77	2.52
1941	12	34.46	16.90	3.06	14.50	11.31
1942	12	18.22	8.25	2.18	7.79	3.73
1943	5	10.34	6.70	1.35	2.29	3.84
1944	7	6.65	3.74	.93	1.98	1.17
1945	5	10.42	4.18	.60	5.64	4.27
1946	4	9.74	3.75	3.23	2.76	3.04
1947	4	9.10	1.84	1.00	6.24	1.73
Average	8.72	12.68	5.92	1.82	4.93	3.28
Percent total rainfall producing runoff			46.69	14.35	38.88	25.87

[1]Source: Fisher, C. E. and Burnett, Earl, "Conservation and Utilization of Soil Moisture," Texas Agriculture Experiment Station, Bulletin 767, 1953.

[2]Torrential—intensity of more than .75 inch per hour. Medium—intensity between .40 and .75 inch per hour. Slow—intensity of less than .40 inch per hour.

The probabilities of annual rainfall amounts of more than and less than various amounts are given in Table 3.

PROBABILITY OF MONTHLY RAINFALL

The probabilities of annual rainfall are shown in Table 4. The probabilities of various rainfall amounts for certain months are shown in Figures 3 and 4.

TABLE 6. PERCENT FREQUENCY OF RAINFALL PERIODS PER MONTH, SPUR

Rainfall periods per month, number	Percent frequency												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
0	14	20	11	2	0	2	5	2	5	7	14	14	8
1	23	16	27	7	9	9	9	9	7	16	23	25	15
2	29	27	23	29	2	11	25	7	23	9	20	25	19
3	18	16	23	32	7	25	29	27	23	30	27	16	23
4	11	9	14	14	32	21	9	21	27	27	5	18	17
5	5	5	2	11	23	9	11	25	11	9	11	2	10
6		7		5	20	14	7	7	2	2			5
7					5	7	5	2	2				2
8					2	2							1
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
Average number rainfall periods	2.0	2.2	2.1	3.0	4.5	3.8	3.1	3.7	3.1	2.9	2.2	2.0	2.9

The percent of the time rainfall will be equal to or less than a certain amount can be found in the table and figures. For example, 2 inches of rainfall or less may be expected 68 percent of the time in April, 38 percent of the time in May and 57 percent of the time in July.

FREQUENCY OF RAINFALL PERIODS

Previous studies at Spur show that the value of rainfall to farmers and ranchers depends on the nature and amount of the rain (and farming and ranching methods). The main features in the nature of the rain are (1) the time interval between rains and (2) the intensity of rainfall. For the entire 44-year period, these features may be approximated by grouping the rainfall observations into rainfall periods. A "rainfall period" is a sequence of days, all having a measurable amount of rainfall. Some rainfall periods will therefore include more than one shower or rainstorm. Rainfall intensity based on the continuous record of a recording rain gage is shown in Table 5. For the period 1926-47, rains that produced runoff were 46.69 percent torrential, 14.35 percent of moderate intensity and 38.88 percent of low intensity.

The percent frequency of months with various numbers of rainfall periods is shown in Table 6. These data show that rainfall periods are least likely to occur in December and January (2.0 each) and most likely to occur in May (4.5). See inside front cover.

AMOUNTS FROM RAINFALLS OF VARIOUS SIZES

Of the 1,527 rainfall periods which occurred during 1912-55, 954, or considerably more than half, brought only half an inch of rain or less, Table 7. Five of the rainfall periods each brought more than 5 inches of rainfall, and each occurred during the warm months, May to October.

Figure 5 shows how rainfall periods of different sizes contribute to the mean monthly rainfalls. In January, nearly all of the rainfall is due to rainfall periods of less than an inch. September receives nearly as much rain in rainfall periods of between 2 and 3 inches as it does in rainfall periods of less than 1 inch, and October receives even more. The mid-summer depression of mean rainfall is due to a small contribution from the large rains; July has about as much rainfall coming in rainfall periods of 1 inch or less as does September.

TABLE 7. SUMMARY OF RAINFALL PERIODS PER MONTH RESULTING IN VARIOUS INCREMENTS, SPUR

Range of moisture per rainfall period, inches	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
0 — .50	72	78	60	76	111	98	94	105	65	63	71	71	954
.51 — 1.00	14	11	19	30	43	29	29	27	35	22	17	12	288
1.01 — 1.50	3	5	10	12	20	20	7	9	9	19	7	2	123
1.51 — 2.00	1		1	3	10	8	8	5	11	6	1	3	57
2.01 — 2.50		1	1	6	5	5	3	5	9	7	1	2	45
2.51 — 3.00		1		3	3	6	4	3	4	6			30
3.01 — 3.50				2	2	2	1	4	3	1			15
3.51 — 4.00					1		1	1	1	2			6
4.01 — 4.50					1		1		1	1			4
4.51 — 5.00													
5.01 — 5.50								1		1			2
5.51 — 6.00													
6.01 — 6.50								1					1
6.51 — 7.00													
7.01 — 7.50					1								1
7.51 — 8.00									1				1
Total	90	96	91	132	197	168	138	161	139	128	97	90	1527

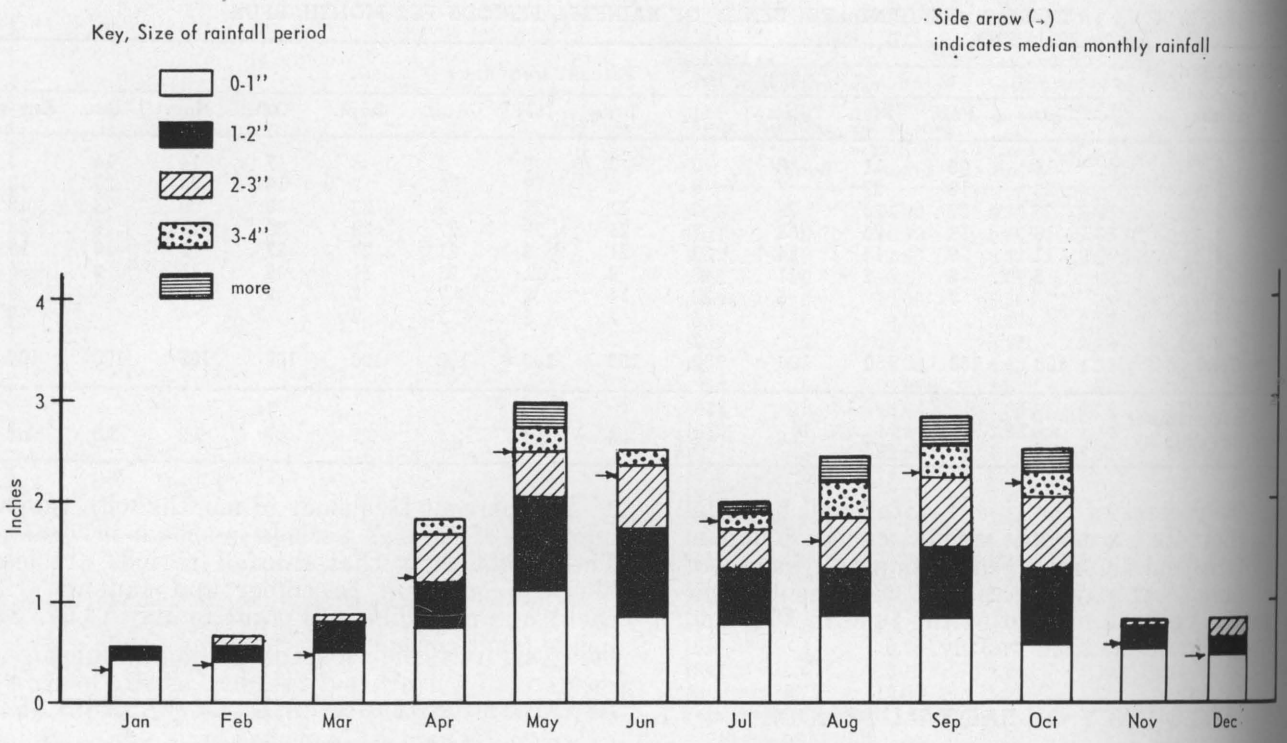

Figure 5. Average rainfall per month due to rainfall periods of various sizes.

BIG RAINS

As was pointed out by Fisher and Burnett, the rains of 2 inches and more offer the main opportunities for building up soil moisture for growing crops. For this reason, the distribution and frequency of these big rains is an essential feature of the rainfall at Spur. In 44 years, there were only 105 rainfall periods which brought 2 inches of rain or more. This is a fraction more than two rainfall periods a year, on the average.

For each month of the year, there is a higher probability that there will be no big rains than that there will be one or more big rains. The most favored month for the big rains is September. The months April through October all have a probability of 20 percent or better of bringing at least one rainfall of 2 inches or more. If the year is divided into a preseasonal period (September through April) and a seasonal period (May through August), then the probabilities of big rains are very nearly equal for the two parts. A sizeable part of the total rainfall from big rains comes in September and October, which may help fall-sown small grains and build up the moisture supply in the subsoil for crop use during the next growing season.

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